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TRANSMITTAL

TO: Jennifer Fitch, PE Project Manager Vermont Agency of Transportation	DATE	PROJECT NO.
	7/29/2014	Brookfield BRF FLBR (2)

XX WE ENCLOSE THE FOLLOWING: _____ UNDER SEPARATE COVER WE ARE SENDING THE FOLLOWING

COPIES	NUMBER	DESCRIPTION	CODE
1		FRP Fabrication NCR 2 - Alignment / Shrinkage	H

CODE:

A FOR INITIAL APPROVAL
B FOR FINAL APPROVAL
C APPROVED AS NOTED-RESUBMISSION REQUIRED
D APPROVED AS NOTED-RESUBMISSION NOT REQUIRED
E DISAPPROVED-RESUBMIT
F QUOTATION REQUESTED
G APPROVED
H FOR APPROVAL
I AS REQUESTED OR REQUIRED
J FOR USE IN ERECTION
K LETTER FOLLOWS
L FOR FIELD CHECK
M FOR YOUR USE

BY: Paul J. Miller

KENWAY
CORPORATION

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July 28, 2014

Mr. Paul Holloway
Miller Construction, Inc
PO Box 86
Windsor, VT 05089

Brookfield BRF FLBR (2)

Dear Mr. Holloway:

Kenway has identified a few production issues now that we are in the middle of fabricating the second pontoon. A summary of the issue and proposed solution(s) for each are listed below.

1. Alignment of Adjoining Pontoons

It became apparent after taking the vacuum bag off the hull that the vertical wall was pulling away from the mold surface by as much as 3/8 in. The hull side pulling inward was not anticipated during design. In fact, the greater concern was how well the pontoon might release from the mold. Kenway pulled the wall back against the mold using numerous clamps along the top edge before installing the bulkheads and foam. We expected the foam to provide adequate resistance to keep the wall aligned after the clamps were removed. However, after the foam cured, it contracted slightly adding to the inward force and causing the vertical wall to tip inward as much as 1/2 in. between bulkheads. Kenway made relief cuts in the foam just inboard of the vertical wall, pulled the wall back against the mold, and filled the resulting gap with additional foam. Now that the part has been out of the mold for approximately one week, the sides have settled inboard between the bulkheads approximately 1/4 to as much as 3/8 in. from vertical at the top edge.

Kenway suggests match casting the two vertical walls by taking the following steps.

1. Grind exterior surface of vertical wall on Pontoon 1 to promote a secondary bond.
2. Vacuum the surface and use compressed air to blow off any remaining dust.
3. Apply a release agent to the mold surface of Pontoon 2.
4. Join the two pontoons ensuring proper alignment and seal the bottom and side edges as well as the threaded rod holes.
5. Fill the gap between pontoons with a pourable transom putty (similar to Arjay Technologies 6011 or SprayCore SC 5000 – see attached information) to match cast the two surfaces.
6. Separate the pontoons and hand lay a single ply of chopped strand mat over the transom putty now adhered to Pontoon 1.
7. Grit blast the mating surfaces of both pontoons per the original plan.

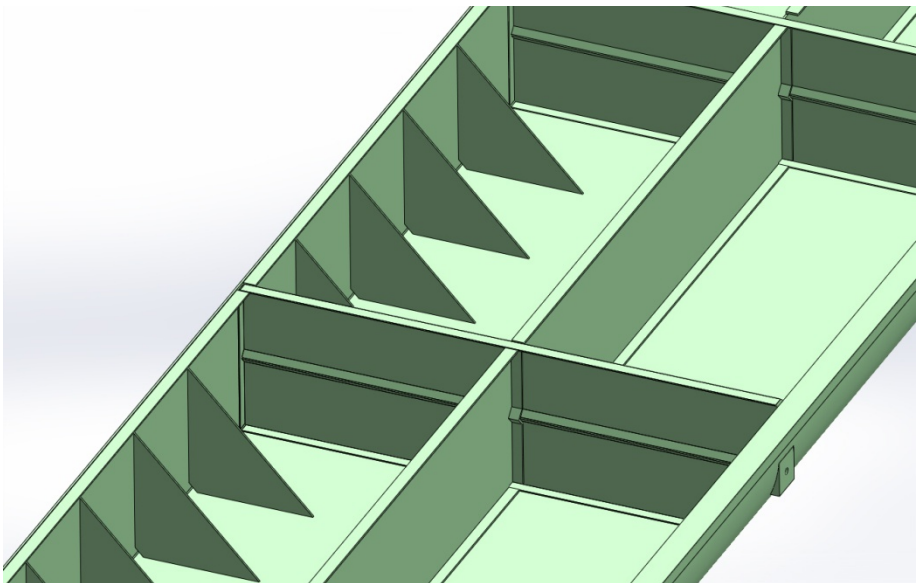
If efforts to maintain sufficient flatness/straightness on the remaining pontoons is not satisfactory, these same steps would be taken to match cast future rafts.

2. Maintaining Vertical on Side Wall

As described above, the side wall of the pontoon hull is pulling inward. Relief cuts were made in the foam of the first pontoon, the wall was wedged outward, and the resulting gap was filled with foam. On the second pontoon, wood bracing was installed from the wall to the longitudinal bulkhead and to the opposing side using wedges to spread the part back against the mold. This ensured the bulkhead remained straight while even pressure was applied to each side. Since some shrinkage was observed in the foam, it was decided that the wood (2x4) bracing should stay in place and that a release film would be placed between the outside walls and the foam. This way, if the foam pulled away from the walls, the resulting gap could be filled after sufficient cure and the desired wall placement would not be lost. The total amount of wood left in the pontoon is about 3 ft^3, which is approximately 0.2% of the total volume of foam. The fact that the pontoon is sealed (watertight) and the wood is encased in closed cell foam eliminates any concern of the wood rotting.

Going forward, Kenway has discussed options for returning the wall to vertical and holding the desired tolerance. The proposed solution is to install a series of FRP gussets along the vertical wall using the following procedure.

1. Remove vac bag from the infused hull after 12 hours under vacuum.
2. Use jacking poles or similar braces to temporarily push the vertical walls back against the mold.
3. Bond 30 x 30 x 1/2 in. thick FRP triangular gussets as shown in the figure below against the vertical wall at 30 in. on center spacing between transverse bulkheads leaving a strong 1 in. fillet of Plexus along each side of the joint.
4. Remove temporary bracing and fill the pontoon with foam in incremental lifts per the existing procedure with the inclusion of a release film on all exterior walls.
5. Fill any gap between the foam and walls that results from shrinkage.



3. Overall Length Shrinkage

Pontoon length was carefully set in the mold using removable inserts at the exact distance required per the drawings. Kenway measured the first pontoon after being out of the mold for just over one week. The overall length of the “short” side of the end pontoon when measured at 70°F is 613-1/2 in., which is right at the tolerance limit. When this is adjusted to 40°F using the measured CTE of 8.76 in/in/°Fx10^{-6}, the overall length will be reduced by 0.161 in. or just over 5/32 in. shrinking the length outside of the required tolerance.

Kenway proposes that the two pontoon hulls already fabricated can be brought back to within tolerance by adding 1/8 to 3/16 in. of laminate to each end. Going forward, the mold inserts that define the ends of the pontoon hulls will be moved out 1/4 in. on each end of the mold. The resulting part shrinkage will pull the overall length back to within 1/8 in. of the design length, which is well within the specified tolerance.

4. Requested Actions

Kenway requests the following approvals:

1. Approval of the match cast procedure described in Section 1 for use on the first raft as well as any future rafts that require it.
2. Approval to leave the 2x4 wood bracing inside Pontoon 2 as noted in Section 2.
3. Approval to try the FRP triangular gussets described in Section 2 inside Pontoon 3 to maintain perpendicularity between wall and floor.
4. Approval to hand lay 1/8 to 3/16 in. of chopped strand mat (CSM) to each end of Pontoons 1 and 2 to get back within length tolerance discussed in Section 3.

Sincerely,

Jacob Marquis

Jacob Marquis, P.E.
Senior Project Engineer

The Performance Products Experts

PRODUCT SPOTLIGHT

Ceramic Pourable Compound (CPC)

Since 1995, Arjay's Ceramic Pourable Compound is Over 50,000 Transoms Strong... and Growing

Boat manufacturing processes have improved a lot over the years, and Arjay has been there every step of the way. Our CPC is becoming the standard for boat hull transoms, where extremely high compressive and flexural strengths and low exotherm in large masses are not only required, they're everything. Today's transoms hold more weight and power than ever before, and failure is not an option.

Hull Liner Method

Hull liner is designed with an aft portion that serves both as an inside form and final inner laminate. Spot application of foam prevents CPC from escaping.

Special FRP Laminate

A laminate (Left) can be laid up off line, is trimmed and tabbed in using spacers to provide the form for pouring and also serve as the inner laminate.

Reusable Form

A natural release material like HDPE can be shaped to provide the inside form for multiple applications. The perimeterof this form must be sealed temporarily with a fairing compound such as Arjay's 1301. After removal, the entire surface should be sanded before application of the interior laminate.

Repair: Rescuing Old Transoms

Many older powerboats were built with plywood transoms, which eventually rot. Arjay's CPC allows repair of these transoms that's minimally invasive, takes less time, and is ultimately more cost effective.

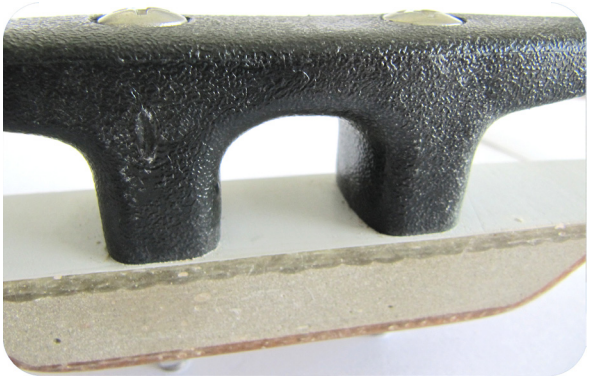
FILLING

ABOVE: Pouring Arjay CPC into cavity between special FRP laminate and hull transom laminate

LEFT: Sealing potential leak points with foam prior to CPC addition

For More Applications, See www.arjaytech.com

OTHER USES



CPC as a Backup for Bolting Hardware
A higher viscosity version (6011HV) can be used as a backup for through bolting marine hardware.

SPECIFICATIONS

COLOR: Gray
ODOR: Styrene
TEXTURE: Grainy
WEIGHT: 7.2 lbs/gal
STABILITY: 4 months

VISCOSITY

RPM:	2	20
µ min:	70,000	42,000
µ max:	92,000	28,000

GEL PROPERTIES

GEL TIME: 21 Minutes
INTERVAL: 52 Minutes
TOTAL: 73 Minutes
PEAK EXO: 130 F.

AVAILABILITY

PAILS

#6011

DRUMS

#6011HV

Arjay Technologies, Inc.
2020 Wild Acres Road • Largo, FL 33771

Office: 727.538.0600
Fax: 727.531.6213

Email: sales@arjaytech.com
Online: www.arjaytech.com

103866 drum
103865 pail

SC 5000 Transom Coring Compound

SC 5000 is a pourable or injectable syntactic transom coring material. MEKP catalyst is not included.

PRODUCT FEATURES

- ☑ **Formulated as a lighter and stronger alternative to plywood**
- ☑ **Helps eliminate rot in the transom area**
- ☑ **Non-friable (unlike most foam cores) – eliminates delamination due to core material breakdown**
- ☑ **Does not need to be cut to shape, just bond with chop or clamp in place**
- ☑ **Offers low shrinkage upon curing**
- ☑ **Designed with excellent bonding properties**

PRODUCT BENEFITS

- ☑ **Helps reduce manufacturing costs**
- ☑ **Speeds up production**
- ☑ **Gives parts better dimensional stability**
- ☑ **Helps improve resistance to impact cracking**

TECHNICAL SPECIFICATIONS

APPEARANCE	PACKAGING	APPLICATION METHOD	APPROXIMATE COVERAGE
Grey	Drum Pail	Pourable Injectable	N/A

MIX RATIO	PREFERED RED DYE CATALYST	GEL TIME	GEL TO PEAK RANGE
1.0% MEKP	MEKP-9H DDM-9	20-30 min	20-30 min

STYRENE	PEAK EXOTHERM (100G MASS)	APPLICATION DENSITY RANGE	VISCOSITY
17%	125-160°F	8.25-8.75 lbs/gal	25,000-35,000 cps (HB#4@20 rpm)

All Properties are measured at 77°F/25°C

SprayCore®

A brand of ITW Polymers Adhesives North America

11701 56th Court North, Clearwater, Florida 33760

Toll Free: 1-866-470-1462 · Phone: 727-573-3545 · Fax: 727-299-9797

Email: info@spraycore.com · Website: www.itwadhesives.com

Paul Holloway

To: Paul Holloway
Subject: FW: Brookfield bridge fabrication
Attachments: Various Fabrication Issues 072814.pdf; ProductSpotlight_CeramicPourablev3.pdf; SC 5000 PIS Data Sheet.pdf

From: Jake Marquis [mailto:jake@kenway.com]
Sent: Monday, July 28, 2014 7:13 PM
To: Paul Holloway
Subject: FW: Brookfield bridge fabrication

From: Joshua Olund [mailto:joshua.olund@tylin.com]
Sent: Friday, July 25, 2014 8:32 AM
To: Jake Marquis; Silk, Joel
Cc: Jagdat, Steven; Greg Wilcox; Robert O'neil; Fitch, Jennifer
Subject: RE: Brookfield bridge

Good morning, Jake and Joel –

This is once again a deviation from the approved fabrication drawings that needs to be considered by VTrans. At this time, I need to remind that the timber bracing has not been reviewed/approved and therefore its permanent presence in the pontoons leaves them subject to rejection.

At a minimum for consideration of the use of permanent timber bracing, please provide:

- an additional description of the need for the timber bracing – why are the walls bowing away from the forms after cure and why wasn't this behavior considered prior to fabrication and shown in the fabrication drawings;

A) Our current assumption is that the walls are bowing in due to a slight differential in the rate of cure – some heat generated during cure was likely absorbed/dissipated in the mold on the bottom side while on the bag (top) side less heat was conducted to the air causing differential shrinkage and the observed pulling. We did not expect this to occur to the degree we're seeing and felt it was very low risk when planning fabrication. In fact, we were much more concerned about being able to release.

- why the timber cannot be removed after foaming operations;

A) If we removed the timber (which we only plan to leave in Pontoon 2), we were concerned the distortion would return prior to the foam being sufficiently cured to resist the laminate.

- long term performance (locked instresses/creep)

A) The timber bracing reduced the bow between transverse bulkheads but did not eliminate it entirely. The final stresses in the laminate, since about half the deflection has returned, are low. These stresses in the laminate will dissipate over time due to creep/relaxation. Primary loads from the post tension rods will be resisted mainly at the bulkheads and the foam backing the side wall will provide some resistance as well. Match casting of Pontoons 1 and 2 will ensure loads are well distributed across the entire vertical wall. The overall displacement of the 2x4s is less than 0.2% of the total foam displacement.

- if timber bracing is needed in exterior bays,

A) All bays received the same timber bracing. The photo provided by the inspector was taken before all bracing was in place.

- if the longitudinal interior web-line is bending due to timber bracing and flattening of the opposite webline

A) After the provided picture was taken, bracing was placed across the hull from side to side to ensure the longitudinal bulkhead remained straight (evenly loaded from both sides).

- method of insuring uniform loading of the pontoons due to added timber

A) The bracing is distributed across an 8 ft 2x4 caul to prevent point loading against the wall and is intended to maintain the desired wall position until the foam is properly cured and able to provide adequate resistance. At that point, the match casting procedure – outlined in Kenway letter dated July 28, 2014 – will ensure the mating faces are evenly loaded through the transverse bulkheads and foam backed span between them.

Thanks.

Josh Olund, PE, PhD
Bridge Engineer
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